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(54) A device suitable for controlling the injection of fuel into an internal combustion engine

(57) A device comprises two processors 11, 21, for example for controlling the injection of fuel into an internal combustion engine. Variables are detected (2) and at least one of the two processors calculates a manipulated variable for supplying (6) to a peripheral unit and controlling the fuel injection. The first processor 11 determines the manipulated variable in dependence on data, more particularly numerical data, calculated by the second processor 21. Each processor 11, 21 may comprise first and second computers 12, 13; 22, 23 and a monitor computer 14, 24. The processors may be connected by a data line having a dual-port RAM 8. The manipulated variable calculated by the first computer 12 may be compared in the monitor computer 24 with the manipulated variable calculated by the second computer 23 to detect faults and actuate a warning light 10.1. A defective processor may be switched off and the other allowed to continue operation. Anti-skid braking systems and robots may alternatively be controlled by the device.

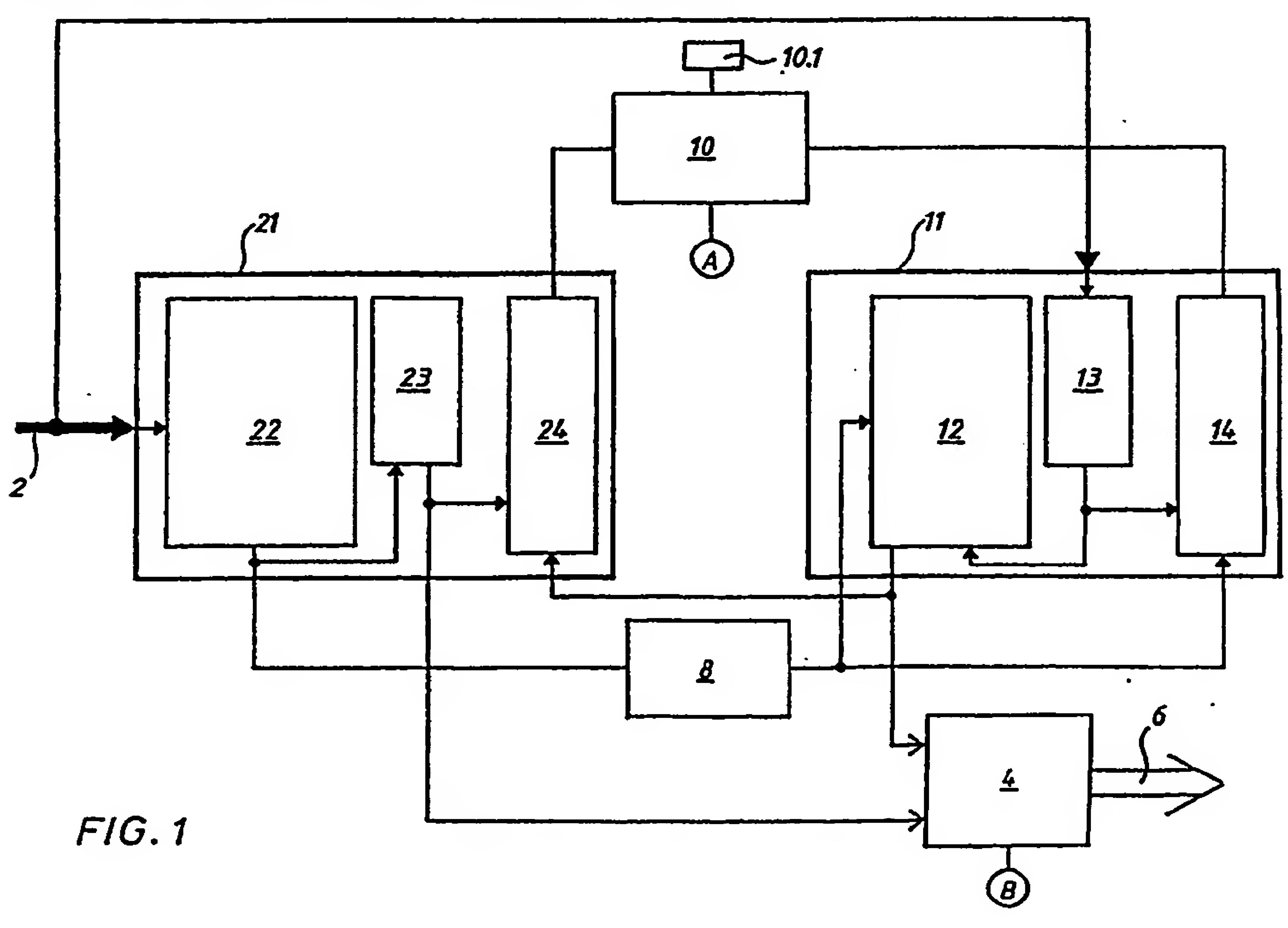

FIG. 1

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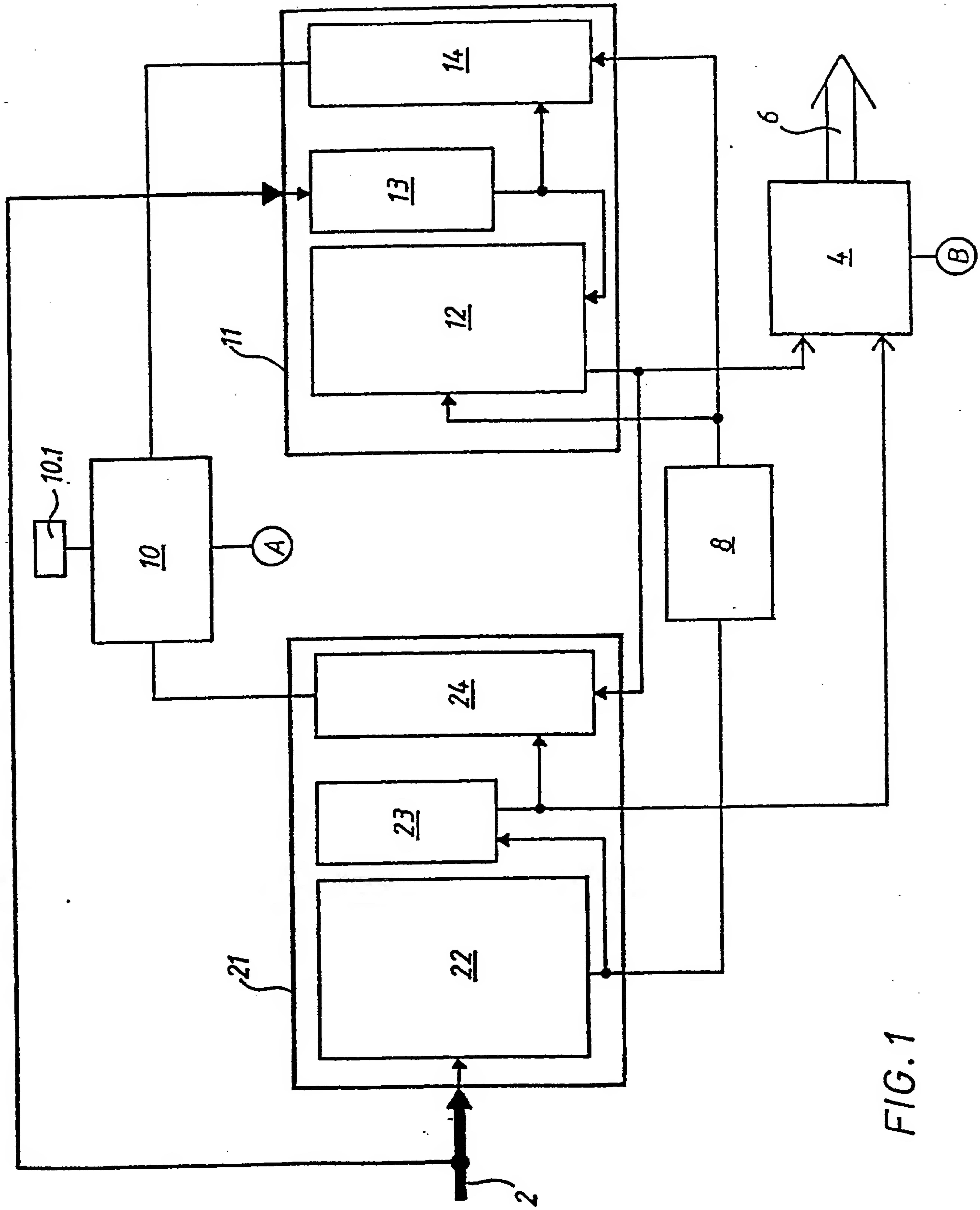

FIG. 1

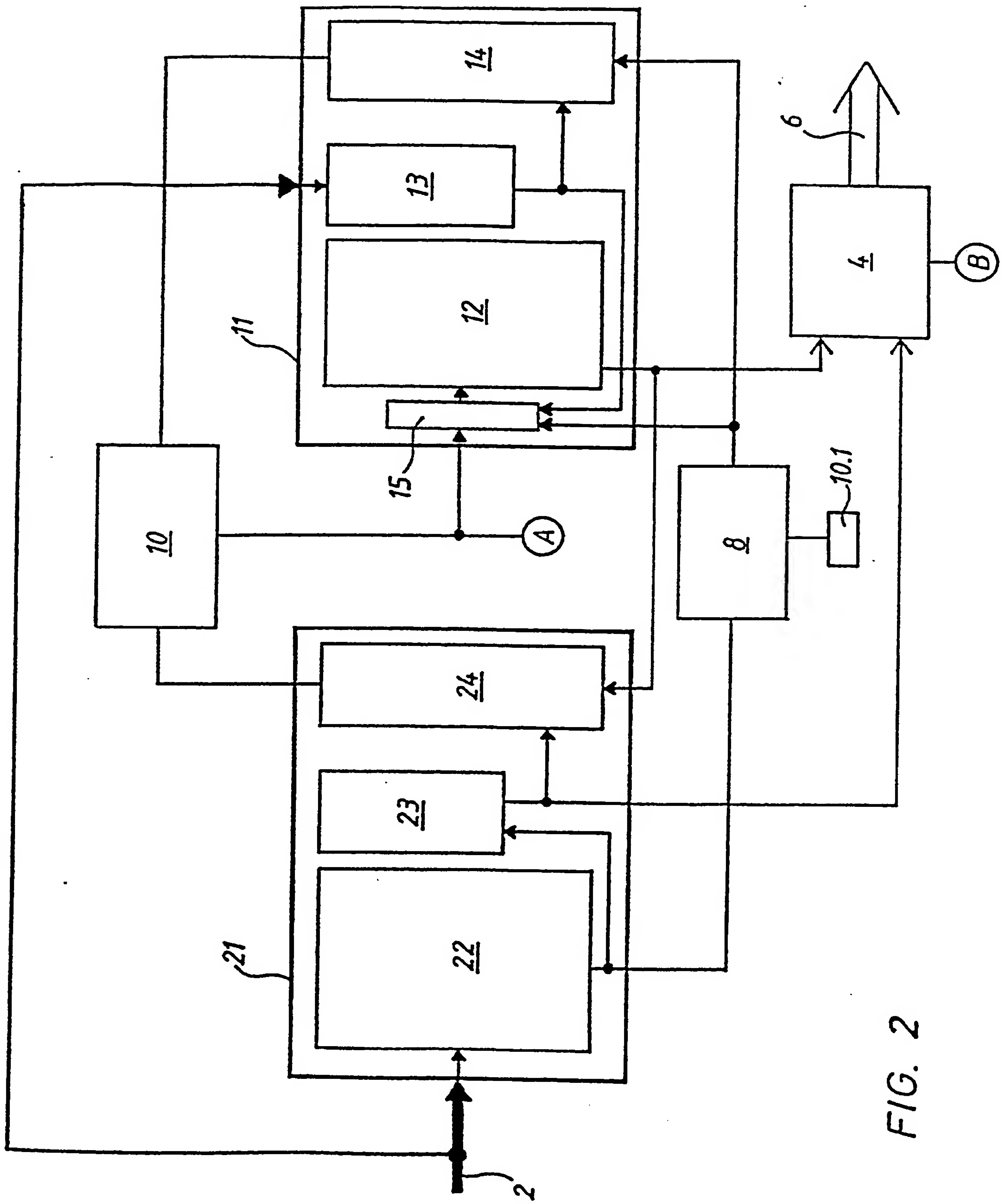

FIG. 2

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A device for controlling the injection of fuel into an internal combustion engine

Description

The invention relates to a device comprising two processors, more particularly for controlling the injection of fuel into an internal combustion engine according to the preamble of claim 1.

A computer system comprising two processors and known in the prior art (DE-OS 35 39 407) is used for adjusting (or controlling) parameters of an engine. A metering device uses detected variables such as the speed, engine power requirement or position of a brake pedal, to generate a set value for the amount of fuel to be injected, the set value being compared with an actual value detected at the control rod in the normal position and representing the amount of fuel injected. Depending on the measured difference, a manipulated variable is delivered to an end stage so as to

adjust the control rod. The set values, actual values and manipulated values processed in the present case are simple voltages, which unfortunately are subject to fluctuations, which may result in faulty adjustment of the control rod. Owing to the use of a number of change-over switches in the signal path, the signal processing is subject to faults. The known computer system has the additional disadvantage that the pick-ups detecting the variables are duplicated, which is complicated and expensive. In the event of a fault, the fault-monitoring devices simply switch off the end stage completely, so that emergency operation is impossible.

The aim of the invention is to provide a device comprising two processors which, in contrast to the prior art, ensures reliable signal processing and rapid determination of the manipulated variable.

This problem is solved by the features disclosed in the characterising part of claim 1.

Since the manipulated variable is calculated in the first processor in dependence on data calculated in the second processor, the manipulated variable can advantageously be determined quickly in dependence on the calculated

variables. Since digital data are processed, the signal processing is also reliable, since these data are not influenced e.g. by a fluctuation in the supply voltage. When the device according to the invention is used for controlling the fuel injection to an internal combustion engine, advantageous account is taken of operating parameters of the engine such as pressure, temperature, speed and more particularly the supply voltage (battery voltage). Other variables such as the power requirement (accelerator pedal position) can also be taken into account. In a special embodiment of the invention, these measured variables are used by the second processor to calculate a set of basic data which is supplied through suitable means (e.g. a data line) to the first processor, which uses the set of basic data to determine the manipulated variable for sending to the peripheral unit in order to control the fuel injection. The peripheral unit is e.g. at least one end stage for actuating one or more injection valves (solenoid valves) or, in general, may be a device for controlling (influencing) the fuel injection (more particularly the beginning, end and rate of injection).

According to another feature of the invention, the manipulated variable determined by the first processor can be supplied to the second processor via a data line, more

particularly with interposition of an input/output unit. The advantage of this is that the manipulated variable determined by the first processor is internally checked for plausibility by the second processor, thus increasing the reliability of signal processing. The input/output unit connecting the two processors is e.g. a central store to which processors have access and data can be written in and read out.

According to another feature of the invention, both processors have at least one computer performing a primary function and one computer performing a secondary function in order to calculate the manipulated variable. The advantage of this is that if one processor fails, the other processor takes over calculating the manipulated variable. To this end, the computers in the first processor carry out at least some of the functions of the computers in the second processor and vice versa. This ensures that if the first processor fails, the computer performing the primary function in the second processor calculates the basic set of data and supplies them to the computer performing the secondary function in the secondary processor, which calculates the manipulated variable, which is sent to the peripheral unit. If the second processor fails, the manipulated variable is calculated in similar manner in the

first processor. If the computers have the same construction in both processors, the engine can continue to operate without restriction if either processor fails. If the computers in one processor carry out only some of the functions of the other processor, emergency operation of the engine is still possible.

According to another feature of the invention, the two processors are associated with a monitoring device which influences the manipulated variable so that in the event of a fault in one of the two processors, the peripheral unit is supplied with the manipulated variable calculated by the functioning processor. By means of the monitoring device associated with the two processors, the peripheral unit in particular can be influenced so that the output of the defective processor (or the output of the peripheral unit) is switched off and the output of the functioning processor delivering the correctly calculated manipulated variable is connected to the peripheral unit or its input is activated. By this means, in the event of a fault in one of the two processors, the engine can continue to operate and faulty controls can be avoided.

According to another feature of the invention, a monitoring computer is incorporated in each processor and supplied with

the output signals of the computer performing the secondary function in one processor and the output signals of the computer performing the primary function in the other processor. The signals supplied to the monitoring computers, which represent the calculated manipulated variable, are checked for plausibility or similarity. In the event of a discrepancy, one of the monitoring computers delivers an appropriate control signal to the monitoring device, which appropriately actuates the peripheral unit. Alternatively the construction can be simplified by using only one monitoring computer in one of the two processors.

According to another feature of the invention, the input variables supplied to the processors are processed by at least one of the processors in time-interlocked intervals, more particularly by multiplexing. This has the advantage that the variables appearing at the inputs of the processors are processed at desired times.

The two-processor device according to the invention is not restricted to controlling the injection of fuel to an engine, but is of use whenever reliable signal processing and rapid determination of a manipulated variable are required. Once such application is e.g. to controlling the brake pressure in an anti-skid system or to the control of

robots in general. If the device according to the invention is used to control the fuel injection to an engine (the main sector of application) the engine can be either diesel or spark-ignition.

One particular embodiment of the device according to the invention and operation thereof will be explained in detail with reference to the drawings and the following description. In the drawings:

Fig. 1 shows a device according to the invention for controlling the injection of fuel into an engine, and

Fig. 2 shows the signal processing in a processor comprising a change-over device.

Fig. 1 shows the device according to the invention for controlling the injection of fuel into an internal combustion engine. The device substantially comprises a first processor 11 and a second processor 21, which is supplied with variables detected through sensor inputs 2. The detected variables, in the case of the device for controlling fuel injection, are operating parameters of the engine such as pressures, temperatures, speeds, positions (e.g. of the crankshaft) and, particularly advantageously,

the supply voltage (battery voltage) to ensure efficient reliable control of fuel injection into the engine. Other variables can be detected and processed, e.g. a variable representing idling or the position of a kick-down switch.

The first processor 11 has a first computer 12 which performs a primary function of the first processor 11, and a second computer 13 which performs a secondary function of the first processor 11. A monitoring computer 14 is also incorporated in the first processor 11. The second processor 21 is constructed in similar manner to the first processor 11 and likewise has a first computer 22 and a second computer 23. A monitoring computer 24 is similarly incorporated in the second processor 21. The two processors 11 and 21 are connected, for the purpose of transmitting signals, to a peripheral unit 4, e.g. at least one end stage for actuating solenoid valves. The solenoid valves or other fuel-metering components are actuated via at least one output line 6, which can be a data line or an electric line. The two processors 11, 21 are also interconnected by an input/output unit 8, more particularly a dual-port RAM, for the purpose of transmitting signals. A monitoring device 10 followed by a diagnostic device 10.1 is associated with the two processors 11 and 21. The monitoring device 10 is connected to the peripheral unit 4 (connection between

points A and B). In a simple embodiment, the diagnostic device 10.1 can be a warning light which is actuated in the event of a fault. Alternatively the diagnostic device 10.1 can be a store, more particularly a non-volatile store, into which suitable fault reports can be written and subsequently read out via an interface.

In the embodiment of the invention shown in Fig. 1, the individual components are connected as follows:

The first computer 12, which calculates the manipulated variable, receives input signals in the form of data written into the input/output unit 8 and the basic data (set of basic data) calculated by the second computer 13. The output of the first computer 12 is connected to the peripheral unit 4 and to the monitoring computer 24 of the second processor 21. The second computer 13 of the first processor 11 has its input connected to the sensor inputs 2 and its output connected to an input of the first computer 12 and to an input of the monitoring computer 14. The first computer 22 of the second processor 21 is supplied with the signals from the sensor inputs 2 and outputs signals to the second computer 23 and to the input/output unit 8. The second computer 23 has its output connected to the monitoring computer 24 and to the peripheral unit 4. The

monitoring device 10 associated with the two processors 11 and 21 is connected to the two monitoring computers 14 and 24.

The aforementioned device for monitoring the fuel injection into an engine operates as follows:

Variables detected via the sensor inputs 2 are supplied to the first computer 22 of the second processor 21, which calculates a set of basic data which is supplied via the input/output unit 8 to the first computer 12 of the first processor 11. The first computer 12, using the set of basic data, calculates a manipulated variable which controls the fuel injection (or the beginning and duration of delivery) and is supplied to the peripheral unit 4. In fault-free operation, the set of basic data calculated by the first computer 22 is supplied to the second computer 23, which corresponds at least partly in operation to the first computer 12 of the first processor 11. In similar manner to the first computer 12, the second computer 23 calculates the manipulated variable which is output to the monitoring computer 24. The manipulated variable calculated by the second computer 23 is compared with the manipulated variable calculated by the first computer 12 in the monitoring computer 24 and, in the event of an unacceptable

discrepancy, the monitoring device 10 is actuated. If the comparison shows a fault in the first computer 12, the monitoring device 10 switches off the output of the first processor 11 and supplies the peripheral unit 4 with the manipulated variable calculated by the second computer 23 of the second processor 21. Correspondingly the second processor 21 is switched off if the monitoring computer 14 comparing its input signals finds an unacceptable discrepancy. In that case the manipulated variable will be calculated by the first computer 12, which is supplied with the set of basic data calculated by the second computer 13.

By means of the aforementioned procedure, if a fault occurs in one of the two processors, the engine can continue to operate at least partially, using the functioning processor. If the computers 12, 13 and 22, 23 incorporated in both processors 11, 21 have the same design, full operation of the engine can be maintained.

Fig. 2 shows signal processing in a processor comprising a switching-over device. In addition to the components shown in Fig. 1 and bearing the same reference numbers, in Fig. 2 a switching-over device 15 is connected upstream of the first computer 12 of the first processor 11 and its input is connected to the monitoring device 10, the input/output unit

8 and the output of the second computer 13. In fault-free operation, therefore, the output signals of the input/output unit 8 are supplied to the first computer 12. In the event of a fault, the switching-over device 15 changes over to the output signals of the second computer 13, whose calculated set of basic data are then supplied to the first computer 12.

The signals input into the switching-over device 15 may be more or fewer than those shown in Fig. 2. Since the switching-over device 15 is a multiplexer, the first computer 12 of the first processor 11 is supplied with input signals in time-interlocked intervals, and can therefore process the input signals in succession. Other multiplexers can be used at other places in the device according to the invention.

The diagnostic device 10.1 associated with the monitoring device 10 in Fig. 1 is associated in Fig. 2 with the input/output unit 8 and performs the same function as described in Fig. 1. Alternatively, the diagnostic device 10.1 can be associated with one or both processors 11, 21 (more particularly the monitoring computer 14 or 24). By this means, an e.g. non-volatile store can be used to file plausibility faults of sensor signals or control signals in

the store and read out these recognised faults from the store and evaluate them, e.g. after a maintenance interval. Also, faults or disturbances occurring in the first processor 11 or its components or in the second processor 21 or its components, can be determined as regards place, nature and frequency and filed in the non-volatile store.

Alternatively, to avoid faulty controls, the output signals e.g. of the peripheral unit 4 can be limited by appropriate hardware. To this end, for example, the output signals, more particularly the beginning and rate of delivery, of the peripheral unit 4, can be limited so that the highest possible speed can be set only at the earliest possible beginning of delivery and the maximum possible delivery rate, so that the engine cannot race or overspeed. This is advantageous e.g. if the manipulated variable calculated by the first processor 11 (or by processor 21 in the event of a fault) is so distorted during transmission as to result in an unacceptable speed of the engine.

In an alternative embodiment essential to the invention, all computers (12, 13, 22, 23) or some computers and/or the monitoring computers (14 and/or 24) can be provided with software, i.e. their operation or partial operation can be brought about in a program (e.g. at least one subroutine of

the main program of one of the two processors or an interrupt routine).

CLAIMS

1. A device comprising two processors, more particularly for controlling the injection of fuel into an internal combustion engine, variables being detected and at least one of the two processors calculating a manipulated variable for supplying to a peripheral unit and controlling the fuel injection, characterised in that the first processor (11) determines the manipulated variable in dependence on data, more particularly numerical data, calculated by the second processor (21).

2. A device according to claim 1, characterised in that the manipulated variable determined by the first processor can be supplied to the second processor (21) via a data line, more particularly with interposition of an input/output unit (8).

3. A device according to claim 1 or 2, characterised in that both processors (11, 12) have at least one computer (12, 13, 22, 23) performing a primary function and one computer performing a secondary function in order to calculate the manipulated variable.

4. A device according to any of the preceding claims, characterised in that the computers (12, 13) in the first processor (11) perform at least a part of the functions of the computers (22, 23) in the second processor (21) and vice versa.

5. A device according to any of the preceding claims, characterised in that the processors (11, 21) are associated with a monitoring device (10) which influences the manipulated variable, more particularly a peripheral unit (4), and if a fault occurs in one of the two processors (11, 21) the peripheral unit (4) is supplied with the manipulated variable calculated by the functioning processor.

6. A device according to any of the preceding claims, characterised in that a monitoring computer (14, 24) is incorporated in each processor (11, 21).

7. A device according to any of the preceding claims, characterised in that at least the processor (11) has a change-over device (15).

8. A device according to any of the preceding claims, characterised in that the input variables supplied to the processors (11, 21) are processed by at least one of the

processors (11, 21) in time-interlocked intervals, more particularly by multiplexing.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

9210814.1

Relevant Technical fields

(i) UK Cl (Edition K) G3N NGBD4, NGK2, NGK2B, NGA2

(ii) Int Cl (Edition 5) F02D, B60T, G05B

Databases (see over)

(i) UK Patent Office

(ii)

Search Examiner

MR M J JONES

Date of Search

13 AUGUST 1992

Documents considered relevant following a search in respect of claims 1-8

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X,E	GB A 2251499 (DELCO) see for example page 9 line 30 to page 10 line 1	1, 2, 4, 5
X	EP A2 0405732 (MARCONI)	1, 2, 4
X	EP A2 0041701 (HITACHI) see Figures 3, 4	1, 2, 4, 5, 6
X	US 4760275 (NIPPODENSO) see Figure 3	1, 2, 4
X	US 3829668 (HITACHI) see Figure 1, 2	1, 2, 4, 5, 6

SF2(p) ME - doc99\fil000214

Category	Identity of document and relevant passages	Relevant to claim(s)

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